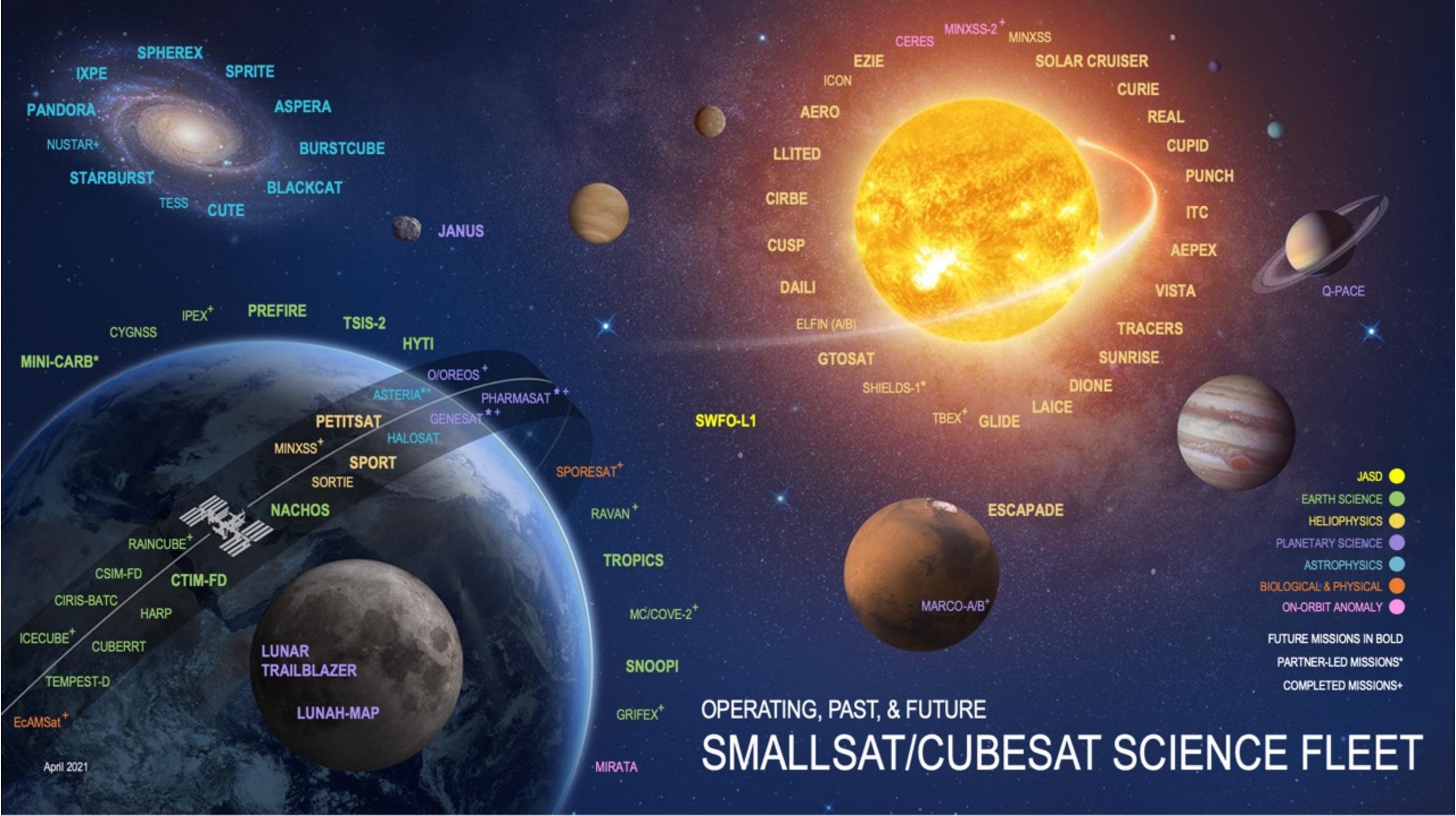


National Aeronautics and  
Space Administration



# Sat Technology Partnerships Tech Expo

an  
Chief Technologist  
Science Mission Directorate  
Earth Science and Applications  
Satellite Coordination Group  
Headquarters  
2021



IXPE  
SPHEREX  
SPRITE  
PANDORA  
ASPERA  
NUSTAR+  
BURSTCUBE  
STARBURST  
TESS  
CUTE  
BLACKCAT  
JANUS

MINI-CARB\*  
CYGNSS  
IPEX+  
PREFIRE  
TSIS-2  
HYTI  
O/OREOS+  
ASTERIA\*\*  
PHARMASAT\*\*  
GENESAT\*\*  
PETITSAT  
MINXSS+  
HALOSAT  
SPORT  
SORTIE  
NACHOS  
RAINCUBE+  
CSIM-FD  
CTIM-FD  
CIRIS-BATC  
HARP  
ICECUBE+  
CUBERRT  
TEMPEST-D  
EcAMSat+  
LUNAR TRAILBLAZER  
LUNAH-MAP

SWFO-L1

CERES  
MINXSS-2+  
MINXSS  
EZIE  
ICON  
AERO  
LLITED  
CIRBE  
CUSP  
DAILI  
ELFIN (A/B)  
GTOSAT  
SHIELDS-1\*  
TBEX+  
GLIDE  
LAICE  
DIONE  
SUNRISE  
TRACERS  
VISTA  
AEPEX  
ITC  
PUNCH  
CUPID  
REAL  
CURIE  
SOLAR CRUISER

SPORESAT+  
RAVAN+  
TROPICS  
MC/COVE-2+  
SNOOPI  
GRIFEX+  
MIRATA  
ESCAPADE  
MARCO-A/B+

- JASD ●
- EARTH SCIENCE ●
- HELIOPHYSICS ●
- PLANETARY SCIENCE ●
- ASTROPHYSICS ●
- BIOLOGICAL & PHYSICAL ●
- ON-ORBIT ANOMALY ●
- FUTURE MISSIONS IN BOLD**
- PARTNER-LED MISSIONS\***
- COMPLETED MISSIONS+**

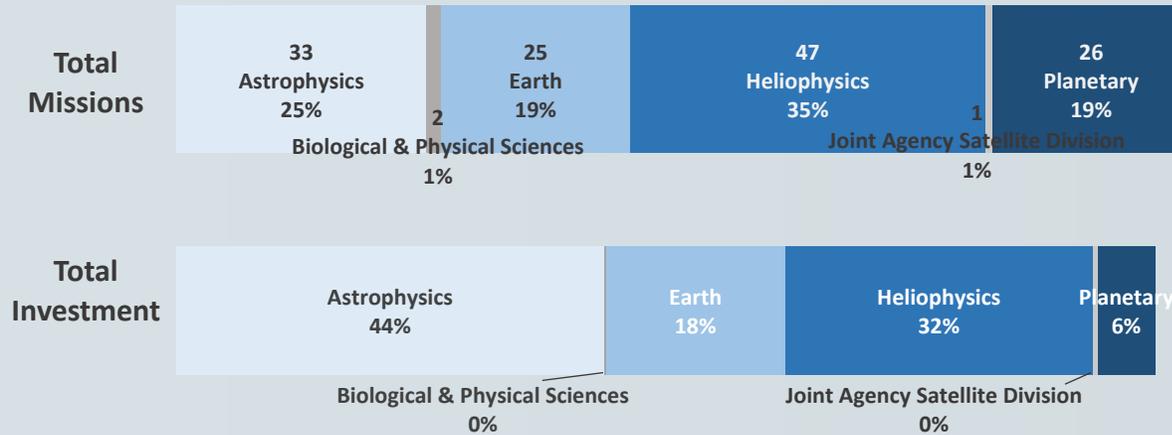
# OPERATING, PAST, & FUTURE SMALLSAT/CUBESAT SCIENCE FLEET

# NASA's Science SmallSat Missions at a Glance

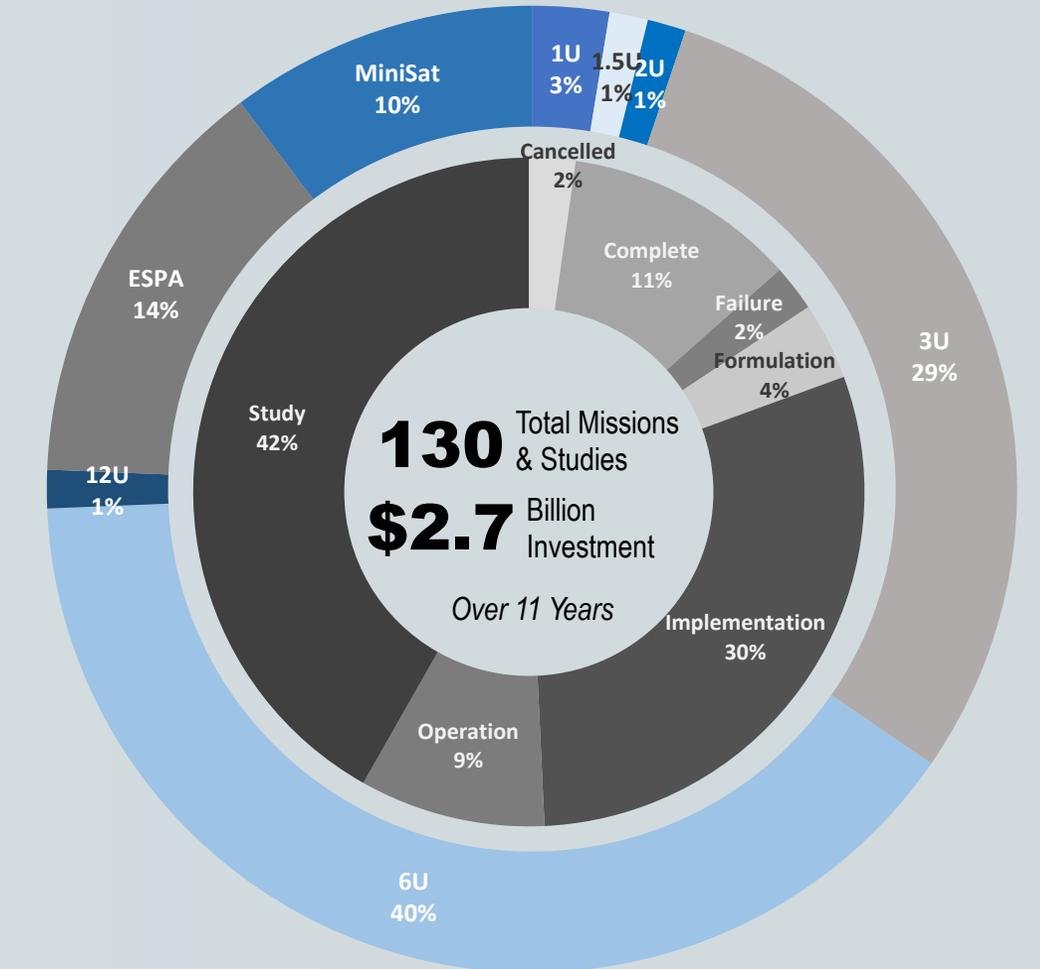
## Inclusive Missions and Studies

Data as of April 2021

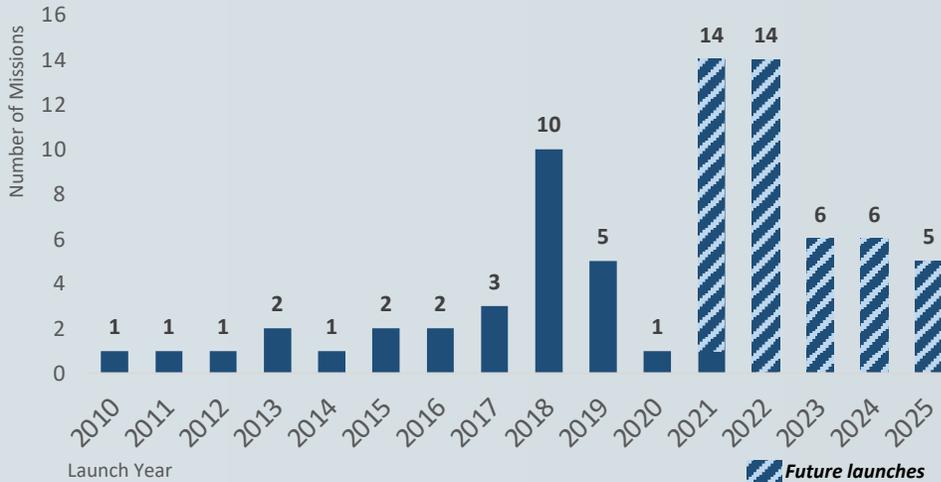
### SmallSat/CubeSat Missions by Division



### Mission Phase and Satellite Size



### Mission Launch Timelines



\*Data inclusive of missions solicited or directed from 2010-2021.

# Why SmallSats?

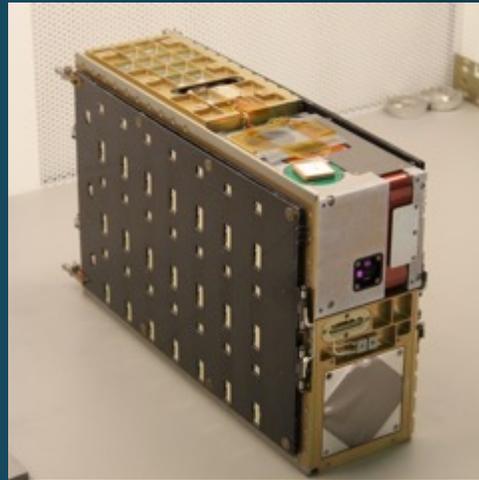
## *The Promise of SmallSats*

- **SmallSats as a balanced program of discovery, increasing our science capabilities**
- New platforms, systems, architectures to enable unique science observations, quicker temporal measurements, data analytics and data fusion, rapid overflights
- Maximizing science return on investment – *imagine the possibilities at the fraction of cost*
  - ***Utilizing Rideshare and dedicated launch vehicles to optimize access to space:*** The IMAP mission has manifested four rideshare missions: GLIDE, Lunar Trailblazer, Solar Cruiser, and SWFO-L1 and the Psyche Mission manifested the Janus spacecrafts
  - ***Utilizing novel architectures such as constellations:*** Multipoint science measurements are significantly more affordable through the use of SmallSat/CubeSat constellations such as CYGNSS, MarCo, TROPICS, TRACERS, PUNCH, ESCAPEDE, Janus, PREFIRE and SUNRISE.
- **SmallSat as platform to train and develop our future workforce**
- **SmallSats to perform Technology Demonstration for future risk reduction**

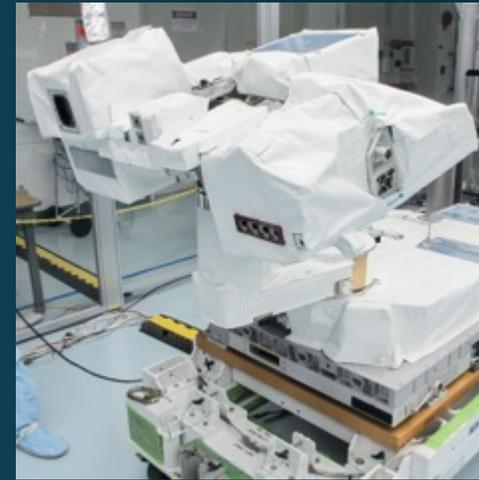
# CSIM-FD

## Compact Solar Irradiance Monitor Flight Demonstration

Measuring solar spectral irradiance (SSI), and how solar variability impacts the Earth's climate, contributing to long-term continuity measurements from *SORCE* SIM and *TSIS* SIM



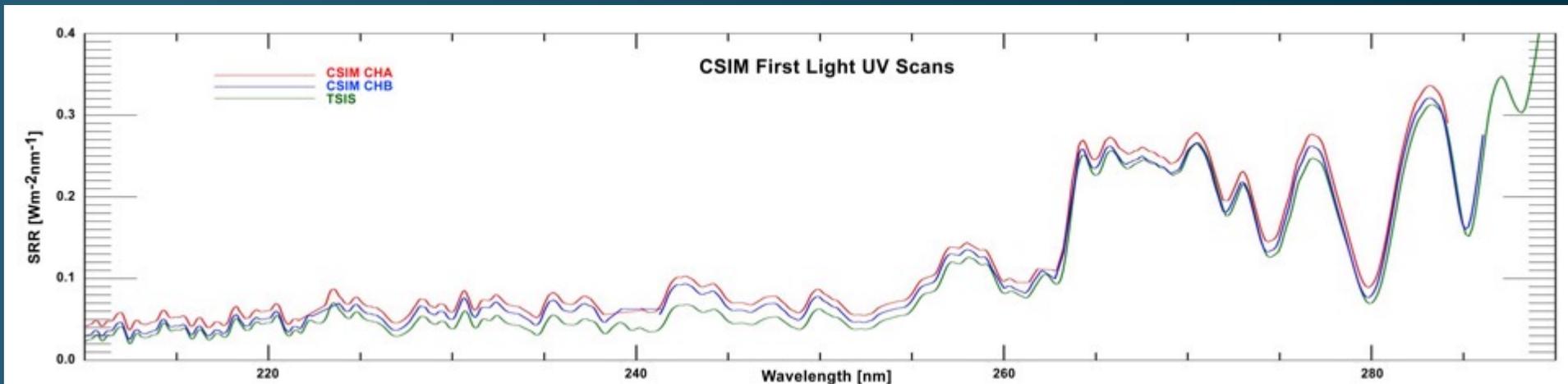
*CSIM is 11 kg based on a Blue Canyon Technologies bus*



*TSIS-1 is 363 kg built by LASP mounted to the ISS*



*SORCE is 290 kg based on an Orbital LEOStar-2 bus*



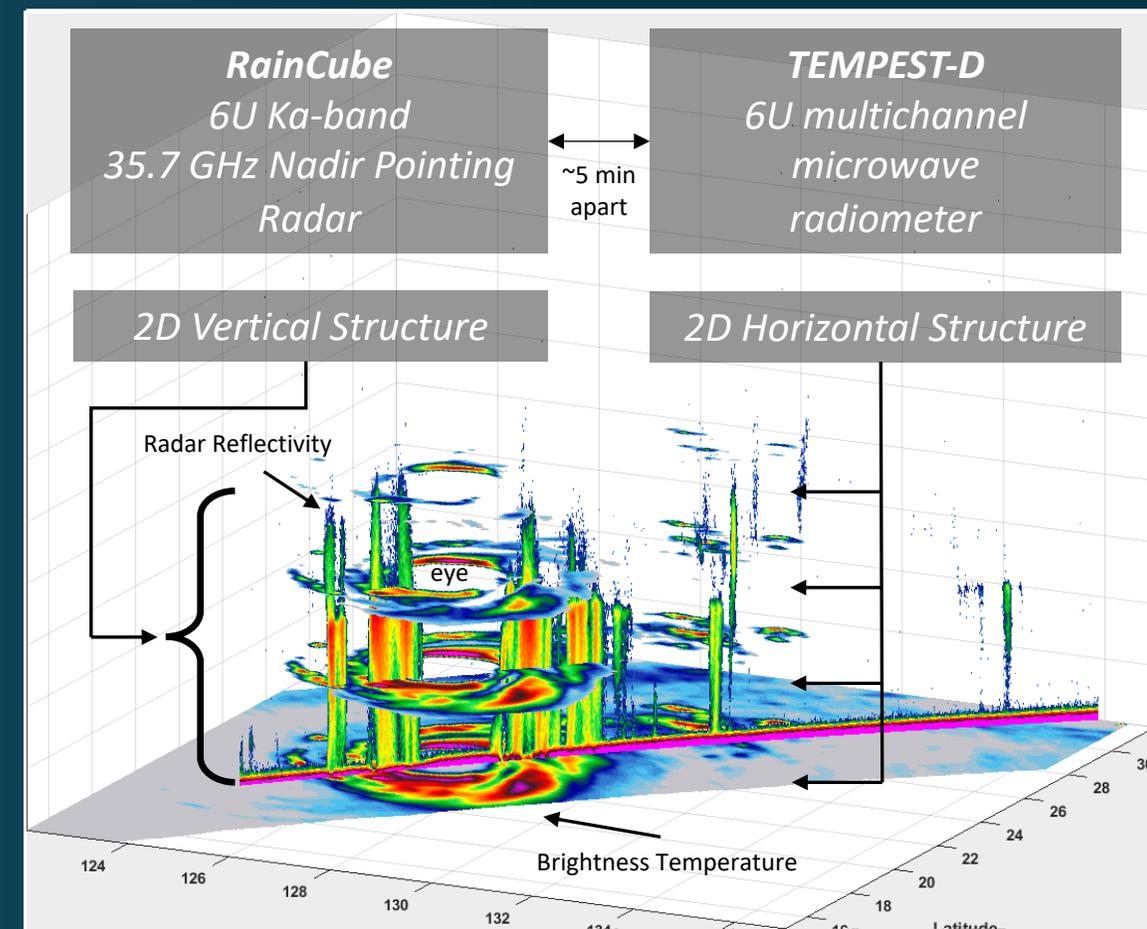
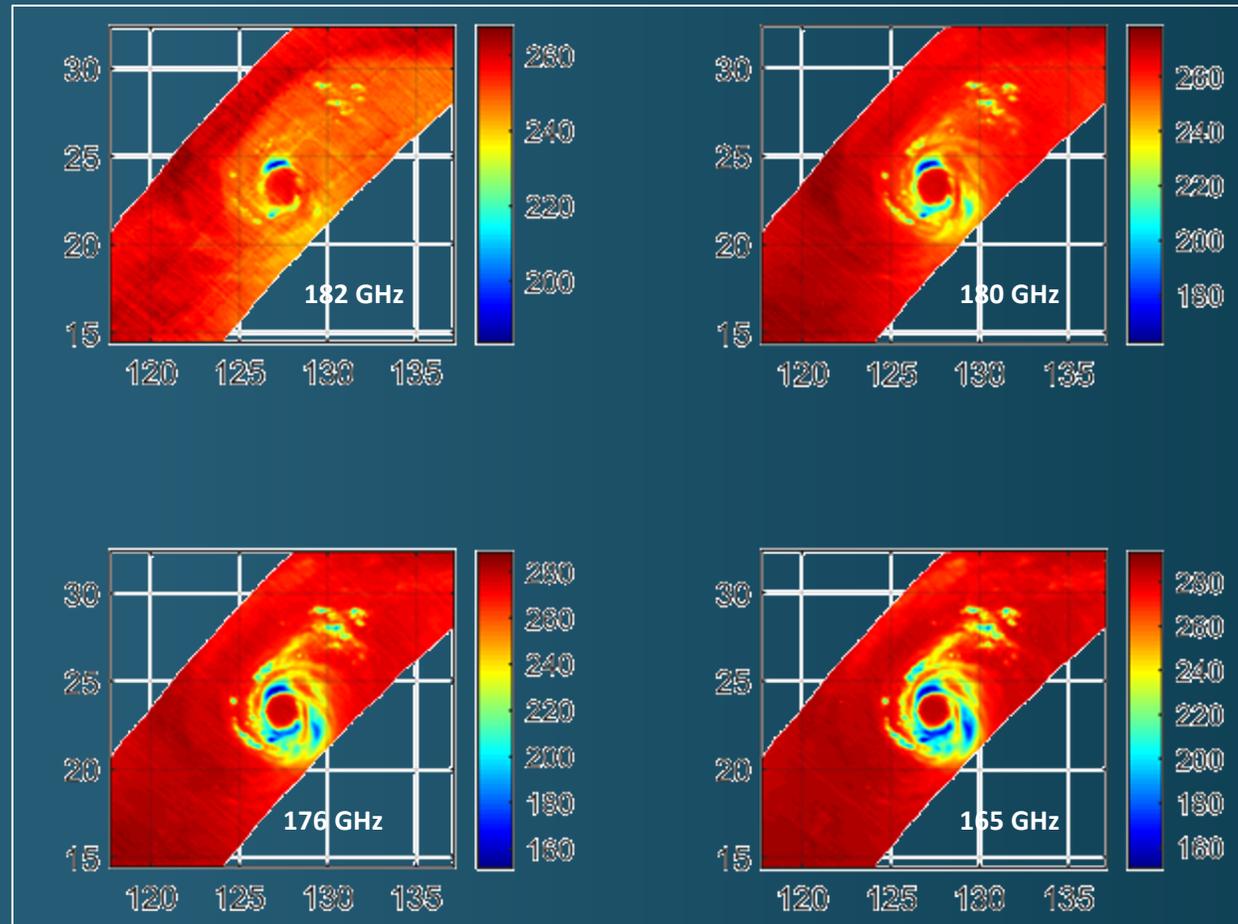
*UV comparison of the first CSIM scan showing excellent agreement to the TSIS spectrum*

Uncorrected CSIM data (channels A and B) compared to TSIS data in a portion of the UV spectrum

**A truly disruptive technology: CSIM-FD provides affordable approach to sustainable measurements for continuity measurements for irradiance monitoring**

# RainCube/TEMPEST-D Observing Typhoon Trami

Spacecraft constellation separated by 5 minutes revealing 3D storm structure



**First heterogeneous constellation measurement: Complementary nature of RainCube and TEMPEST-D missions create new path of observations to augment our measurements and increase our science capability.**

# Challenges

- Low SWaP miniaturized of sensors and payload pipeline technology development, culminating in a rigorous demonstration program.
- Small satellite subsystem technologies have rapidly matured; focused investments and strategic partnerships needed to advance technologies for deep space ESPA-class systems.
- Propulsive ESPA is an enabling technology for complex multi-spacecraft science missions, but flight demonstrations are needed to prove and mature this capability
- Drag modulated aerocapture enables more resiliency to launch targets
- Industry has advanced rapidly to provide turn-key reliable, global, high-bandwidth, secure solutions for communications for SmallSats and CubeSats, especially in LEO; radio compatibility, licensing and encryption remain challenging for our PIs
- Conjunction Risk for Autonomous operations especially in light of the rise of the Mega-Constellations
- New insights from multi-instrument constellation data fusion and analytics
- Cooperative synergies among large and small missions.



# SMD SmallSat and Technology

SMD Technology Programs sponsored by our divisions:

<https://science.nasa.gov/technology/smd-technology-programs>

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## SMD Technology Programs

SMD develops cutting-edge technologies to enable groundbreaking science via technology development programs sponsored by its science divisions.

- Astrophysics**
  - Strategic Astrophysics Technology (SAT)
  - Astrophysics Research and Analysis (APRA)
  - Nancy Grace Roman Technology Fellowships (RTF)
  - Pioneers Program
- Heliophysics**
  - Heliophysics Technology and Instrument Development for Science (H-TiDeS)
  - Heliophysics Low Cost Access to Space (H-LCAS)
  - Heliophysics Flight Opportunities for Research and Technology (H-FORT)
- Biological and Physical Sciences**
  - Space Biology Program
  - Physical Sciences Program
- Planetary Science**
  - (Managed by the Planetary Exploration Science Technology Office (PESTO))
- Earth Science**
  - (Managed by the Earth Science Technology Office (ESTO))
- Crosscutting Programs**
  - Applied Information Systems Research
  - Autonomous Robotics Research for Ocean Worlds

A vertical beam of light illuminates a cosmic scene. At the top, there are blue and purple galaxies and a bright star. Below that, a planet with rings (Saturn) and a crescent moon are visible. At the bottom of the beam, a bright orange sun is shown, with a silhouette of a person standing with arms raised in front of it. The beam is reflected on the floor below.

# NASA

**EXPLORE**  
with us

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